

CLAIMS

What is claimed is:

1. A method of forming package assemblies for optically interactive electronic devices comprising:
providing a wafer of semiconductor material having a plurality of optically interactive devices formed thereon, wherein each optically interactive device comprises an image sensitive area disposed on a front surface of the wafer and at least one bond pad adjacent to a peripheral edge of the image sensitive area;
bonding a transparent cover to the front surface of the wafer with an adhesive material, wherein the transparent cover extends over the plurality of optically interactive devices;
sectioning the transparent cover around the peripheral edge of the image sensitive area of each optically interactive device such that a portion of the transparent cover remains over the image sensitive area of each optically interactive device and the at least one bond pad of each optically interactive device is exposed;
cutting the wafer to separate the plurality of optically interactive devices from one another;
attaching the plurality of optically interactive devices to a first surface of an interposer;
electrically connecting the at least one bond pad of each optically interactive device to at least one attachment pad of a plurality of attachment pads on the first surface of the interposer;
forming a layer of encapsulant material over the first surface of the interposer to cover the plurality of optically interactive devices, wherein the portion of the transparent cover remaining over the image sensitive area of each optically interactive device is exposed through the layer of encapsulant material; and
cutting the interposer and the layer of encapsulant material at locations between the plurality of optically interactive devices to form a plurality of individual package assemblies.

2. The method of claim 1, wherein bonding the transparent cover to the front surface of the wafer with an adhesive material comprises applying the adhesive material to at least one of the front surface of the wafer and the transparent cover in a pattern such that the adhesive material lies between the peripheral edge of the image sensitive area and the at least one bond pad of each optically interactive device.

3. The method of claim 1, wherein bonding the transparent cover to the front surface of the wafer with an adhesive material comprises applying the adhesive material to at least one of the front surface of the wafer and the transparent cover in a pattern such that the adhesive material surrounds the peripheral edge of the image sensitive area and covers the at least one bond pad of each optically interactive device.

4. The method of claim 1, wherein sectioning the transparent cover around the peripheral edge of the image sensitive area of each optically interactive device comprises cutting the transparent cover with a saw.

5. The method of claim 4, wherein cutting the transparent cover with a saw comprises cutting with a saw blade having a width that is substantially equal to a distance between the image sensitive areas of the plurality of optically interactive devices.

6. The method of claim 4, wherein cutting the transparent cover with a saw comprises: cutting along the peripheral edges of image sensitive areas of a first row of optically interactive devices; and cutting along the peripheral edges of image sensitive areas of a second, adjacent row of optically interactive devices.

7. The method of claim 4, wherein cutting the transparent cover with a saw comprises cutting a channel in the transparent cover between a first row of optically interactive devices and a second row of optically interactive devices, and further comprising: removing a portion of the transparent cover and a portion of the adhesive material adjacent to the channel with an etching process.

8. The method of claim 1, further comprising: removing a layer of semiconductor material from a back surface of the wafer prior to sectioning the transparent cover.

9. The method of claim 1, wherein the interposer has a plurality of external connection points on a second surface thereof, and further comprising: forming a discrete conductive element on each external connection point of the plurality of external connection points.

10. The method of claim 1, wherein attaching the plurality of optically interactive devices to the first surface of the interposer comprises attaching each optically interactive device with a layer of adhesive material.

11. The method of claim 1, wherein forming the layer of encapsulant material over the first surface of the interposer comprises applying the encapsulant material by one of a transfer molding process, a pot molding process, an injection molding process, a liquid dispensing process, a photolithographic deposition process, and a stereolithographic deposition process.

12. The method of claim 1, wherein the encapsulant material is selected to comprise one of a silicon-filled polymer and a liquid crystal polymer.

13. The method of claim 1, wherein the plurality of optically interactive devices is selected to comprise a plurality of image sensor chips.

14. The method of claim 1, wherein electrically connecting the at least one bond pad of each optically interactive device to at least one attachment pad comprises forming a wire bond between the at least one bond pad of each optically interactive device and the at least one attachment pad.

15. The method of claim 1, further comprising:
forming at least one conductive trace on each optically interactive device after cutting the wafer to separate the plurality of optically interactive devices from one another, wherein the at least one conductive trace extends from at least one bond pad on a first surface of each optically interactive device to a second, opposing surface of the optically interactive device; and
forming a conductive bump on the at least one conductive trace of each optically interactive device.

16. The method of claim 15, wherein attaching the plurality of optically interactive devices to the first surface of the interposer and electrically connecting the at least one bond pad of each optically interactive device to at least one attachment pad comprises bonding the conductive bump on the at least one conductive trace of each optically interactive device to the at least one attachment pad.

17. An electronic device package assembly comprising: [~]
an interposer having at least one conductive pathway including an attachment pad on a first surface of the interposer;
an optically interactive device mounted to the interposer and having an active surface with an image sensitive area and at least one bond pad adjacent to the image sensitive area;
a transparent cover bonded over the image sensitive area with an adhesive material, wherein the adhesive material is adhered to the active surface of the optically interactive device between a peripheral edge of the image sensitive area and the at least one bond pad;
an electrical connection between the at least one bond pad and the attachment pad of the at least one conductive pathway of the interposer; and
a layer of encapsulant material over the first surface of the interposer covering the optically interactive device, wherein the transparent cover is exposed through the layer of encapsulant material.

18. The electronic device package assembly of claim 17, wherein a peripheral edge of the transparent cover is located at a point between the peripheral edge of the image sensitive area and the at least one bond pad of the optically interactive device.

19. The electronic device package assembly of claim 17, wherein the at least one conductive pathway of the interposer includes an external connection point on a second, opposing surface of the interposer.

20. The electronic device package assembly of claim 19, further comprising a discrete conductive element attached to the external connection point of the at least one conductive pathway.

21. The electronic device package of claim 17, wherein the optically interactive device is mounted to the interposer with a layer of adhesive material.

22. The electronic device package of claim 17, wherein the layer of encapsulant material comprises one of a silicon-filled polymer and a liquid crystal polymer.

23. The electronic device package of claim 17, wherein the optically interactive device comprises an image sensor chip.

24. The electronic device package of claim 17, wherein the electrical connection between the at least one bond pad of the optically interactive device and the attachment pad of the at least one conductive pathway of the interposer comprises a wire bond.

25. The electronic device package of claim 17, wherein the electrical connection between the at least one bond pad of the optically interactive device and the attachment pad of the at least one conductive pathway of the interposer comprises a conductive trace extending from the at least one bond pad on the active surface of the optically interactive device to a backside of the optically interactive device.

26. The electronic device package of claim 25, wherein the conductive trace is bonded to the attachment pad with a conductive bump comprising solder, conductive or conductor-filled epoxy, or metallic plating.

27. A method of forming package assemblies for optically interactive electronic devices comprising:
providing a wafer of semiconductor material having a plurality of optically interactive devices formed thereon, wherein each optically interactive device comprises an image sensitive area disposed on a front surface of the wafer and at least one conductive via extending from the front surface of the wafer to a back surface of the wafer;
bonding a transparent cover to the front surface of the wafer with an adhesive material, wherein the transparent cover extends over the plurality of optically interactive devices;
forming a conductive bump over the at least one conductive via of each optically interactive device on the back surface of the wafer;
cutting the wafer and the transparent cover to separate the plurality of optically interactive devices from one another;
attaching the plurality of optically interactive devices to a first surface of an interposer by bonding the conductive bump over the at least one conductive via of each optically interactive device to an attachment pad of a plurality of attachment pads on the first surface of the interposer;
forming a layer of encapsulant material over the first surface of the interposer to cover the plurality of optically interactive devices, wherein a portion of the transparent cover remaining over the image sensitive area of each optically interactive device is exposed through the layer of encapsulant material; and
cutting the interposer and the layer of encapsulant material at locations between the plurality of optically interactive devices to form a plurality of individual package assemblies.

28. The method of claim 27, wherein bonding a transparent cover to the front surface of the wafer with an adhesive material comprises applying the adhesive material to at least one of the front surface of the wafer and the transparent cover in a pattern such that the adhesive material covers the front surface of the wafer with the image sensitive area of each optically interactive device exposed through the adhesive material.

29. The method of claim 27, wherein cutting the wafer and the transparent cover to separate the plurality of optically interactive devices from one another comprises simultaneously cutting the wafer and the transparent cover with a saw.

30. The method of claim 27, further comprising:
removing a layer of semiconductor material from the back surface of the wafer to expose the at least one conductive via of each optically interactive device prior to forming a conductive bump over the at least one conductive via of each optically interactive device.

31. The method of claim 27, wherein the interposer has a plurality of external connection points on a second surface thereof, and further comprising:
forming a discrete conductive element on each external connection point of the plurality of external connection points.

32. The method of claim 27, wherein forming the layer of encapsulant material over the first surface of the interposer comprises applying the encapsulant material by one of a transfer molding process, a pot molding process, an injection molding process, a liquid dispensing process, a photolithographic deposition process, and a stereolithographic deposition process.

33. The method of claim 27, wherein the encapsulant material is selected to comprise one of a silicon-filled polymer and a liquid crystal polymer.

34. The method of claim 27, wherein the plurality of optically interactive devices is selected to comprise a plurality of image sensor chips.

35. An electronic device package assembly comprising:
an interposer having at least one conductive pathway including an attachment pad on a first surface of the interposer;
an optically interactive device mounted to the interposer and having an active surface with an image sensitive area and at least one conductive via extending from the active surface to an opposing, back surface of the optically interactive device, wherein the at least one conductive via has a conductive bump bonded to the attachment pad of the at least one conductive pathway of the interposer;
a transparent cover bonded over the image sensitive area with an adhesive material, wherein the adhesive material covers the active surface of the optically interactive device around a peripheral edge of the image sensitive area; and
a layer of encapsulant material over the first surface of the interposer covering the optically interactive device, wherein the transparent cover is exposed through the layer of encapsulant material.

36. The electronic device package assembly of claim 35, wherein the at least one conductive pathway of the interposer includes an external connection point on a second, opposing surface of the interposer.

37. The electronic device package assembly of claim 36, further comprising a discrete conductive element attached to the external connection point of the at least one conductive pathway.

38. The electronic device package of claim 35, wherein the layer of encapsulant material comprises one of a silicon-filled polymer and a liquid crystal polymer.

39. The electronic device package of claim 35, wherein the optically interactive device comprises an image sensor chip.

40. The electronic device package of claim 35, wherein the conductive bump of the at least one conductive via comprises solder, conductive or conductor-filled epoxy, or metallic plating.

41. A method of forming package assemblies for optically interactive electronic devices comprising:

providing a wafer of semiconductor material having a plurality of optically interactive devices formed thereon, wherein each optically interactive device comprises an image sensitive area disposed on a front surface of the wafer and at least one bond pad adjacent to a peripheral edge of the image sensitive area;

cutting the wafer to separate the plurality of optically interactive devices from one another;

attaching the plurality of optically interactive devices to a first surface of an interposer;

forming a wire bond extending from the at least one bond pad of each optically interactive device to at least one attachment pad of a plurality of attachment pads on the first surface of the interposer;

bonding a transparent cover to each optically interactive device with an adhesive material, wherein the adhesive material surrounds a peripheral edge of the image sensitive area of each optically interactive device and covers the at least one bond pad of each optically interactive device;

forming a layer of encapsulant material over the first surface of the interposer to cover the plurality of optically interactive devices, wherein the transparent cover on each optically interactive device is exposed through the layer of encapsulant material; and

cutting the interposer and the layer of encapsulant material at locations between the plurality of optically interactive devices to form a plurality of individual package assemblies.

42. The method of claim 41, wherein the interposer has a plurality of external connection points on a second surface thereof, and further comprising:

forming a discrete conductive element on each external connection point of the plurality of external connection points.

43. The method of claim 41, wherein attaching the plurality of optically interactive devices to the first surface of the interposer comprises attaching each optically interactive device with a layer of adhesive material.

44. The method of claim 41, wherein forming the layer of encapsulant material over the first surface of the interposer comprises applying the encapsulant material by one of a transfer molding process, a pot molding process, an injection molding process, a liquid dispensing process, a photolithographic deposition process, and a stereolithographic deposition process.

45. The method of claim 41, wherein the encapsulant material is selected to comprise one of a silicon-filled polymer and a liquid crystal polymer.

46. The method of claim 41, wherein the plurality of optically interactive devices is selected to comprise a plurality of image sensor chips.

47. An electronic device package assembly comprising:
an interposer having at least one conductive pathway including an attachment pad on a first surface of the interposer;
an optically interactive device mounted to the interposer and having an active surface with an image sensitive area and at least one bond pad adjacent to the image sensitive area;
a wire bond extending from the at least one bond pad to the attachment pad of the at least one conductive pathway of the interposer;
a transparent cover bonded to the active surface of the optically interactive device with an adhesive material, wherein the adhesive material surrounds a peripheral edge of the image sensitive area of the optically interactive device and covers the at least one bond pad of the optically interactive device; and
a layer of encapsulant material over the first surface of the interposer covering the optically interactive device, wherein the transparent cover is exposed through the layer of encapsulant material.

48. The electronic device package assembly of claim 47, wherein the at least one conductive pathway of the interposer includes an external connection point on a second, opposing surface of the interposer.

49. The electronic device package assembly of claim 48, further comprising a discrete conductive element attached to the external connection point of the at least one conductive pathway.

50. The electronic device package of claim 47, wherein the optically interactive device is mounted to the interposer with a layer of adhesive material.

51. The electronic device package of claim 47, wherein the layer of encapsulant material comprises one of a silicon-filled polymer and a liquid crystal polymer.

52. The electronic device package of claim 47, wherein the optically interactive device comprises an image sensor chip.

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53. A method of forming package assemblies for optically interactive electronic devices comprising:

providing a wafer of semiconductor material having a plurality of optically interactive devices formed thereon, wherein each optically interactive device comprises an image sensitive area disposed on a front surface of the wafer;

bonding a transparent cover to the front surface of the wafer with an adhesive material, wherein the transparent cover extends over the plurality of optically interactive devices;

sectioning the transparent cover around the peripheral edge of the image sensitive area of each optically interactive device such that a portion of the transparent cover remains over the image sensitive area of each optically interactive device;

cutting the wafer to separate the plurality of optically interactive devices from one another;

attaching the plurality of optically interactive devices to a surface of an interposer;

electrically connecting each optically interactive device to at least one conductive pathway on the interposer;

cutting the interposer at locations between the plurality of optically interactive devices to form a plurality of individual package subassemblies;

mounting at least one individual package subassembly of the plurality of individual package subassemblies within a cavity of a preformed package housing;

electrically connecting the at least one individual package subassembly to at least one conductive pathway in the cavity of the preformed package housing; and

at least partially filling the cavity of the preformed package housing with a sealant material.

54. An electronic device package assembly comprising:

- a package housing having a cavity and at least one conductive pathway including an attachment pad within the cavity;
- an interposer mounted within the cavity of the package housing having at least one conductive pathway including an attachment pad on a surface of the interposer, wherein the at least one conductive pathway of the interposer is electrically connected to the attachment pad within the cavity of the package housing;
- an optically interactive device mounted to the interposer and having an active surface with an image sensitive area, wherein the optically interactive device is electrically connected to the attachment pad on the surface of the interposer;
- a transparent cover bonded over the image sensitive area of the optically interactive device with an adhesive material, wherein the adhesive material is adhered to the active surface of the optically interactive device around a peripheral edge of the image sensitive area; and
- a sealant material at least partially filling the cavity of the package housing.

55. A method of forming package assemblies for optically interactive electronic devices comprising:
providing a wafer of semiconductor material having a plurality of optically interactive devices formed thereon, wherein each optically interactive device comprises an image sensitive area disposed on a front surface of the wafer;
bonding a transparent cover to the front surface of the wafer with an adhesive material, wherein the transparent cover extends over the plurality of optically interactive devices;
sectioning the transparent cover around the peripheral edge of the image sensitive area of each optically interactive device such that a portion of the transparent cover remains over the image sensitive area of each optically interactive device;
cutting the wafer to separate the plurality of optically interactive devices from one another;
mounting at least one optically interactive device of the plurality of optically interactive devices within a cavity of a preformed package housing;
electrically connecting the at least one optically interactive device to at least one conductive pathway in the cavity of the preformed package housing; and
at least partially filling the cavity of the preformed package housing with a sealant material.

56. An electronic device package assembly comprising:
a package housing having a cavity and at least one conductive pathway including an attachment pad within the cavity;
an optically interactive device mounted within the cavity of the package housing, wherein the optically interactive device is electrically connected to the attachment pad within the cavity;
a transparent cover bonded over the image sensitive area of the optically interactive device with an adhesive material, wherein the adhesive material is adhered to the active surface of the optically interactive device around a peripheral edge of the image sensitive area; and
a sealant material at least partially filling the cavity of the package housing.